An investigation of the effectiveness of using advance organizers and literacy strategies to promote student learning in mathematics

Harriet Donaldson

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Research Questions: Do advance organizers and instructional strategies designed to improve student literacy levels improve student achievement in mathematics? What is the impact on student engagement and motivation levels when the above are used?

Abstract

This study was designed to improve motivation and attitude towards mathematics in a mainstream Year 10 class, in a co-educational urban school. Many students in the class displayed a lack of endurance with set tasks, and needed prompting to complete a minimum amount of work. Some expressed a lack of confidence in their ability to succeed in the subject, and were easily distracted. The teacher approached the school's Resource Teacher: Learning and Behaviour (RTLB) to explore possible strategies, that when delivered to the whole class, would be of benefit to all students. Their subsequent collaboration involved the RTLB adopting the role of researcher, while the teacher implemented an intervention designed to measure the effects of a combination of strategies.

The students involved in this study displayed a lack of motivation and an apathetic attitude toward mathematics work. They expressed frustration, and a sense of helplessness in the classroom. This was indicated by a range of behaviour and utterances, which included, "How are we supposed to remember all that?" "What's he going on about?" They gave up on tasks readily, and had to be constantly reminded to get on with their work. It was noticeable in the classroom that the teacher spent a great deal of time responding to individual student's requests for help. Despite students having the resources to help themselves, they did not do so spontaneously. It was posited that using advance organizers might help them to regulate their own

activities more effectively, enabling them to become independent learners and improving self-efficacy levels.

Academic engaged time and student achievement were measured pre and post intervention. Student feedback was sought in the form of a questionnaire and semi-structured interview. Results indicate advance organizers, in combination with other strategies, are an effective tool that can contribute to improving student achievement and can re-orient student effort in appropriate ways.

A number of implications for teachers and classroom practice were made, most significantly, that when advance organizers are used in conjunction with other carefully selected strategies, and presented to learners as part of a well-designed classroom programme, learning is enhanced, and students report, more enjoyable.

Literature Review

An advance organizer is an instructional strategy introduced prior to a lesson. Its function is to key students into the lesson content, linking new material or ideas to be learnt to those already within a student's cognitive structure. It makes explicit to the student how new information can be linked to old, and so helps students to conceptualize, rather than see new information as a bunch of stand-alone facts (Joyce & Weil, 1996). However, advance organizers promote learning conditionally, and are dependent on whether the organiser is used appropriately and accurately. A student's ability to link information in the advance organizer correctly with new information is critical (Kloster & Winne, 1989; Lenz, Alley & Schumaker, 1987). The learner must actively reflect on the new material, think through these linkages, reconcile differences or discrepancies, and note similarities with existing conditions (Joyce & Weil, 1996).

An analysis of advance organizer research presents a conflicting and confusing picture. A number of authors report that advance organizers do not facilitate learning (Kenny, 1993; Moskow & Ledford, 1986) however Mayer (1979), refutes the critics. He reports there is a small but consistent advantage for groups of students using advance organizers. Parker (1998) examined the effects on take-up time (the time it took students to begin work after being instructed to start), on-task behaviour, and reading comprehension, when an advance organizer was introduced. Parker's results support those of Mayer. Her findings also suggest that teachers can learn how to construct and present an advance organizer in a relatively short amount of time, and that all students can benefit, particularly less able learners.

Luiten, Ames and Ackerson (1980) carried out a meta-analysis of approximately 135 studies covering the period from 1960 to 1979. In each of the studies analysed, the most important feature considered was the magnitude of the effect of the advance organizer on learning and retention. They concluded that advance organizers had a small but facilitative effect on learning and retention, and that they facilitated learning in all content areas examined, and with individuals in all grade and ability levels.

Ausubel (1963), who first advanced this theory of learning in the 1960's, drew a parallel between the way subject matter is organized and the way people organize knowledge in their minds. Just as each of the academic disciplines has a structure of concepts that are organized hierarchically, so can students similarly organize new ideas and knowledge. Ausubel describes the mind as an information-processing, and information-storing system, and compares it to the conceptual structure of an academic discipline. In the case of mathematics, the spiral curriculum is designed to first of all facilitate the learning of concrete concepts (Ministry of education, 1992). More abstract concepts are built onto this as students develop understanding and knowledge. Learning is facilitated when students use the existing structure of the discipline, and develop an intellectual map to guide them in their analysis of particular domains, and solve problems within those domains (Joyce & Weil, 1996).

Vygotsky supports this theory of learning, and argues that the capacity to learn through instruction is itself a fundamental feature of human intelligence. When teachers provide students with the means to access learning that would otherwise be unavailable to them, they are fostering the development of knowledge and ability (Wood, 1999). One of Vygotsky's main contributions to educational theory is a concept termed the 'zone of proximal development' (Berk & Winsler, 1997). This term applies to the gap that exists for the learner between what he is able to do alone, and what he can achieve with help from a more knowledgeable peer or teacher. In the case of this study it was hypothesised that students could be empowered to bridge this gap using the advance organizer as an aid to learning, enabling them to make connections for themselves, to be more willing to take responsibility for, and to determine the usefulness of current, and future learning.

Advance organizers provide students with a framework from which to develop their ideas. As the teacher guides students through the advance organizer, meanings and concepts are negotiated with students that help them to make sense of new learning and make links with previous knowledge. New words are explored and their meanings clarified, so that learners develop a shared understanding and terminology. This is especially important in mathematics where many words used in every day discourse often have special and technical implications. Unless new words are fully embedded into students' understandings, they may fall back on previously learnt interpretations, causing confusion and inhibiting progress. Direct teaching helps students acquire the specialized vocabulary in mathematics that is vital for academic success.

According to Vygotsky language is the centrepiece of cognitive development and rich classroom talk can promote higher-order, literate modes of communicating and thinking (Wood, 1999). In order to co-construct meaning and understanding, the teacher needs to become aware of what students think, know, and understand, and to engage with this body of knowledge. This shift in perspective, from defining the teacher as someone who supports students to learn, to someone who empowers students to learn for themselves, has become known as the co-constructivist perspective (McNaughton, 1995).

In the case of this intervention co-construction occurred through the use of specific acts of teaching, which encouraged students to articulate their developing ideas and understandings. As they made links to prior learning and new knowledge acquisition, the teacher's familiarity with the curriculum allowed him to skilfully rework and elaborate on these contributions. These were often added to the advance organizer, making it a learning tool constructed by all, during a "meeting of minds" (McNaughton, 2002). To facilitate the process of co-construction the teacher explained the purposes of the advance organizer, modelled its use, and supported students as they incorporated it into their repertoire. Initially, it was explicitly explained how the advance organizer would be used. After a period of time however, students, with the teacher, developed shared ways of using it.

The researcher and teacher held the belief that effective patterns of co-construction can be achieved when planned programmes of work are delivered in classroom settings sympathetic to learners and their needs. This premise drove decisions around instructional design, which was adapted throughout the intervention in response to our increasing awareness of the students we were working with. For example, the teacher noticed that when he used scaffolding (Wood, Bruner & Ross, 1976) with some students, he was able to help them see the 'sameness' in some tasks, and aid them in linking new and prior learning, and that often during this process students exclaimed they had 'got it.' It was also noted that when more able students engaged in spontaneous peer tutoring relationships with less able students, similar results were experienced. Research shows that effective scaffolding has a number of components and gaols. It involves joint problem solving and a belief that students learn best when they are working with others to find solutions. Intersubjectivity is also a quality of good scaffolding, resulting in shared understandings (Berk & Winsler, 1997). This occurs when the teacher points out the links between new and previous learning, supporting the students while they develop new understandings and interpretations. Maintaining affirming and responsive relationships with students is also necessary for effective scaffolding, as is keeping the level of challenge and the amount of teacher intervention at appropriate levels. Promoting self-regulation is an important goal of scaffolding, and was especially important in this learning context. As mentioned previously the teacher spent a disproportionate amount of time attending to individual's requests for clarification, or simply repeating instructions. Using questions to elicit students thinking and developing their ideas encouraged students to participate in the discovery of solutions and answers. This maximised opportunities for them to become independent problem solvers, and established the expectation that they would strive to do so.

The elements of this intervention oppose Piaget's views on intellectual development,- that children have a 'natural' capacity to develop mathematical concepts and understandings, and that this happens at different stages during the child's development - and points to a belief in the importance of instruction in helping students to make sense of their mathematical experiences. There is a body of research to suggest a student's ability to acquire mathematical knowledge and understandings is influenced by factors such as task familiarity, the language used and the manner in which the learning is introduced and explained (Wood, 1999).

Vygotsky argued that instruction leads to new knowledge and skills. Bruner supports this argument, and emphasises the place of social interaction, language and instruction in the learning process (Berk & Winsler, 1997). Obviously the quality of both the instruction, and the design of the teaching programme delivered are significant if effectively meeting students' learning needs is the goal. Gagnë, Briggs and Wager (1988) describe instruction as, "a deliberately arranged set of external events designed to support internal learning processes" . These events include:

- gaining the learners undivided attention,
- sharing the learning objectives and teacher expectations,
- revisiting prior learning,
- presenting the learning material effectively,
- guiding the learning through discussion, clarification, conferencing,
- involving the learner through eliciting response,
- providing ongoing feedback about performance,
- assessing the performance and providing additional feedback; and
- arranging for a variety of practice to aid future retrieval and transfer.

By following these principles of instructional design, and selecting teaching strategies that take into account the learner, the learning context and the learning objectives, teachers can positively influence outcomes for students. Through careful consideration, and by choosing effective strategies, the external conditions of learning can facilitate the kinds of 'internal processing that will lead to rapid obstacle-free learning' (Gagnë, Briggs & Wager, 1988). They suggest that as part of the planning for instructional programmes, decisions around what must be learnt, how this will be learnt, and how the learning programme will be evaluated must be made, and that these decisions are most effective when teachers use their existing knowledge of how the individuals in their classrooms learn. This knowledge is the basis for appropriate decision-making around the selection of effective teaching strategies.

If the use of an advance organizer is deemed appropriate, decisions around the form the organizer will take, and the design of the learning activities that will support it remain. The variety in medium and form of advance organizer allows them to be used whatever teaching style the teacher prefers and as an adjunct to any instructional program, they provide additional structure to the material and provide advance notice of what is critical for the student to learn (Story, 1998).

A number of different kinds of organizer are described in the literature, including those using video, television, and computer assisted instruction. Pictorial graphic organizers, participatory organizers (those with blanks for students to fill in) and final form organizers (those presented by the teacher as complete). Joyce and Weil, cited in Story (1998) list a variety of forms organizers can take, including statements, paragraphs, questions, demonstrations, films, dialogue, and stories. Other forms are audio, slides, computer programs, objects, games, video tapes, maps, manipulative materials, concrete models and the concept map – described as a visual representations of the hierarchical relationships between concepts in a discipline. These have all been used by teachers and researchers with varying results (Story, 1998).

Braselton and Decker (1994) describe how they used an advance organizer to facilitate the teaching of mathematical word problems to fifth graders who were not reading word problems for meaning, and so could not decipher relevant from irrelevant material. Because the focus of the program was to improve content area reading comprehension, problems were selected that would reflect experiences familiar to most of the students. Each problem was read and discussed; and when possible, students acted out the events described. Students were encouraged to write, rewrite, and discuss word problem solutions. They were encouraged to think of each problem as a short story from which they could make meaning by using their prior experience. They then used a five-step strategy introduced by their teachers. After using the combination of advance organizer and strategy, students showed marked improvement in their ability to perform word problems. It seems that when students use strategies to integrate both language and mathematics skills their ability to function as independent problem solvers is greatly increased. They concluded advance organizers are an effective tool that, when used in combination with other strategies, improve the ability of students to independently solve mathematical problems.

It was decided to include, in every mathematics lesson, strategies adapted from the resource, *Effective Literacy Practice in Years 9 – 13* (Ministry of Education, 2003). This was the key reference supporting whole school professional development in literacy, delivered by an external advisor and the school's literacy leader, at the time of the research. A belief that all teachers are teachers of literacy, because all students learn through language (Ministry of Education, 2004), compelled the teacher and researcher to include instructional strategies as part of the intervention. A variety of strategies were selected depending on the learning intention and students' needs.

Learners need a repertoire of strategies in order to acquire literacy, and they need to use these in combination in order to decode and encode, make meaning and think critically. Applying processing and comprehension strategies in an integrated way involves an awareness of how print works, an understanding of phonics, accessing prior knowledge and experiences, and utilising strategies for making meaning of unknown words (Ministry of Education, 2004).

Each of the essential learning areas places its own literacy demands on learners and these need to be taken into account when programme planning. The curriculum literacies needed by students in order for them to construct the knowledge of any learning area, such as forms of text and specialist language, need to be explicitly taught to students (Ministry of Education, 2004). The literacy required for learning mathematics is different from other subjects. This places added responsibility onto the mathematics teacher, who must ensure students have the means to meet the general aims of mathematics education described in Mathematics in the New Zealand Curriculum (Learning Media, 1992).

Freebody and Luke (cited in *Literacy Leadership in New Zealand Schools*, 2002), identify a useful framework of literacy practices that when incorporated into well-designed programmes of work improve outcomes for students in all learning areas. These practices are: code-breaking, meaning-making, text-using and text-analysing. Code-breaking is the decoding and encoding of written and spoken tests, and in mathematics includes:

> *Recognizing different types of content words: belonging to the subject (e.g. cosine, rhombus); used in mathematics and in everyday English with different meaning (e.g. ray, product, term, concurrent); meaning different things in mathematics (e.g. square, simplify); having a consistent meaning in mathematics (e.g. calculate, find, work out, compute).*
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> *Literacy Leadership in New Zealand Schools, Years 9 – 13*, 2002, page 45

This framework provided clear direction and guidance to both the teacher and myself, and helped raise our awareness of the ways we could reduce potential obstacles to learning when developing learning outcomes.

Informed by the research and encouraged by the versatility and variety of advance organizers, the researcher and teacher wanted to see if the incorporation of advance organizers, and other instructional strategies could improve certain aspects of student learning, and if so, in what ways? They set out to gather information on this, and other questions including, what is the impact on academic engaged time when advance organizers, and games designed to promote acquisition and understanding of mathematical terms, become part of the classroom routine?

Method

Choosing the research tool is vitally important for the success of any research project. Cresswell (1994) lists five useful criteria to use as a guide to decision making. These are: the researcher's world-view, training and experience, their psychological attributes, the nature of the problem, and the audience for whom the research is intended.

An examination of the characteristics of qualitative and quantitative research, whilst highlighting the strengths and weaknesses of both, indicated the former to be the most suitable for the purposes of this researcher, as dictated by the setting, preferred methods of data gathering, and the need for an evolving and flexible design (Bogdan, & Biklen, 1998).

Two important factors influencing the design of this project were the context that is the classroom setting, and the important ethical considerations around each student's right to a quality education. Protecting the existing and ongoing relationships the teacher shared with the subjects was crucial for the ongoing successful delivery of the mathematics curriculum. John Dewey, the American philosopher and educator, once said that education is a social process (Cohen and Manion, 1997). Both teacher and researcher placed a high value on ensuring positive relationships existed with, and between students. To this end, they remained open and responsive to their suggestions, opinions, ideas and contributions in relation to the management of classroom activities, throughout the research. The teacher readily called on his experience of teaching mathematics, and his understanding of human behaviour, to adapt instruction for individuals or small groups as the need arose. This intuitive ability to readily discern a student's comfort level with tasks, and refine and adapt these as required, demonstrated to the students that their learning was paramount to both the teacher and researcher. This resulted in a shared culture of respect and caring, and a positive classroom tone was established. This emphasis on empathic, trusting relationships belongs to the qualitative tradition (Bogdan & Biklen, 1998).

Perceived limitations of qualitative research are; it is time consuming, data reduction is difficult, there are issues with reliability, the procedures are not standardised, and it is difficult to study large numbers. Other problems can be lack of external validity, lack of generalisabilty, 'observer effect,' the presence of the researcher in the process, and internal validity. The effects of these limitations can be greatly reduced by the researcher selecting an appropriate research design.

Given the above considerations and parameters, two types of research methods were examined, experiments and quasi-experiments. The essential feature of experimental research is that investigators deliberately control and manipulate the conditions that determine events in which they are interested. This involves changing the value of one variable – called the independent variable – and observing the effect of that change on another variable – called the dependent variable. In this type of study random selection of groups is essential, and for this reason experimental research was ruled out as students in the class came together by means other that random selection. The general form of the research is therefore quasi-experimentation, as strict experimental conditions could not be reproduced in the classroom setting, nor was this desirable for this study. Kerlinger (1970) refers to quasi-experimental situations as 'compromise designs,' this refers to the nature of educational research where the randomization of exposures – essential in true experimental design – is impractical.

As stated, quasi-experimental methods cater for designs involving experimental and control groups that are not randomly grouped. The presence of a control group makes this design favourable to the one group pretest /post-test design, where the researcher measures a group on a dependent variable, then introduces an experimental manipulation, then measures the result, attributing the change to the effects of the manipulation. The weakness in this design is that it is impossible to measure the impact of extraneous variables. When selecting a control group, Kerlinger (1970) advises selecting a group that are as alike as possible to the experimental group.

On examination of the Progressive Achievement Test scores in mathematics, reading comprehension and vocabulary, a class of Year 10 students of similar academic ability as the experimental class were selected. Other similarities included gender balance, age, socio-economic background, and learning experiences. Both groups were delivered similar content material and undertook identical common tests.

Obviously it is impossible to control all extraneous variables that might cloud the effects of an intervention. However, it is reasonable to assume both groups will experience many of these variables, such as factors in pupils' personal lives, variability in the quality of teaching, and events and happenings in and around the school. This makes it more probable that differences in performance are caused by the intervention.

Guba and Lincoln, (cited in Schofield, 1989) suggest a way of generalising qualitative results by analysing the degree to which the situation studied matches other situations in which one is interested. They refer to this concept as 'fittingness'. The effectiveness of this depends on supplying clear and detailed descriptions as a means of allowing decisions about the extent to which findings from one study are applicable to other situations. Goetz and Le Compte (cited in Schofield, 1989) suggest more useful concepts are comparability and translatability. Stake (cited in Denzin & Lincoln, 1994) suggests it is possible to take the findings of one study, and apply them to understanding another similar situation, by making naturalistic generalisations.

Questions around internal and external validity remain. Notably, internal validity may be compromised due to the study being of a yearlong's duration, and the effects of the resultant increase in maturation levels of students, who are also more likely to become sensitized to the purpose of the experiment, over such a time period. Using a multi-method design added rigour to the research process by providing data from more than one source, which was then triangulated. This also helps to overcome possible 'observer effects', Phillips (cited in Eisner & Peshkin, 1990) states that while observations are not free from the influence of background theories or hypotheses, or personal hopes and desires, people from a wide variety of theoretical frameworks can agree on the facts. While the teacher and researcher had a vested interest in improving the quality of teaching and learning in the classroom, they remained open as to how this could best be done. When different methods of data collection yield substantially the same results, the researcher can have more confidence in the causal relationship being explored (Cohen & Manion, 1997). External validity is important if the findings of the research are to be successfully generalized to other similar populations or settings. However, this study was undertaken simply to provide information on a unique set of circumstances, although the teacher was interested in acquiring skills and knowledge that would be transferable to similar contexts.

Before embarking on the actual intervention a pilot was carried out to identify any possible problems in connection with any aspect of the investigation. The researcher and teacher worked collaboratively, and followed all agreed-on procedures. However, refinements and changes to these were made throughout the ongoing investigation, mainly in response to students' needs, both behavioural and academic.

Procedures

At the time of the research, the researcher was working as a Resource Teacher: Learning and Behaviour, and had previously worked successfully with the teacher to bring about change for groups and individuals. During shared professional dialogue, the teacher expressed a wish to improve the learning outcomes for this class, and after exploring a number of possibilities it was decided to undertake a research programme.

The research was undertaken in two stages, both stages carried out by the same teacher and researcher. The first stage involved the teacher and researcher perfecting and gaining confidence with the writing and presenting of advance organizers via the teacher's laptop computer, connected to a television screen mounted on the classroom wall. To this end a pilot study was carried out on a Year 9 class. This initial stage of the research allowed the teacher and researcher to refine the research process, and gain an indication of student response to the methods used.

The research in stage one was carried out for four periods per week, over 10 weeks. Data collection involved interval recordings of on-task behaviour, anecdotal observations and semi-structured interviews. Interval recordings of on-task behaviour involved ten randomly selected students being monitored at 2.5 minute intervals for a period of 10 seconds. If the student remained on-task for the whole 10 seconds of the observed time, they were considered to be on-task and were recorded as being so. Each student continued to be monitored until the interval-recording sheet was complete, (see appendix A). This record of on-task-behaviour was converted to an average and used to describe the percentage on-task behaviour of the whole class. Ten students were selected randomly each time. This was done initially for 4 lessons over one week to provide a baseline. These scores were later compared to the results of interval- recordings taken after the advance organizer had been implemented, to gauge improvement in on-task behaviour.

Anecdotal observations were made and shared between the teacher and researcher at the end of each lesson. Meetings between the teacher and researcher were ongoing throughout the research process, and through these discussion refinements were made to lesson planning and instructional design.

A range of literacy strategies were incorporated into the classroom programme. These were adapted from *Effective Literacy Strategies in Years 9 to 13* (Ministry of Education, 2004). Examples of strategies used included word maps, clustering, pair definitions, matching activities and word games, including crosswords.
One game, structured like 'bingo', involved students using different laminated game boards, with one student acting as the caller. This student called out either a word or definition; students matched this to either a word or definition on their game board, and covered it with a counter. On completion of the game board, a student calls 'bingo'. Then they repeat both the words and their definitions from the examples on their game board, and the caller checks this, with the class listening and helping if necessary.

Example 1. Bingo game board.

To change a shapes position in space	When you transform an object you get its?	All angles and lengths of a shape are equal
How much you enlarge a shape by	To make a turn to the left	What is a polygon with six sides and six angles called?
A specific point in space is denoted by using a pair of what?	A triangle with sides of different length, and three different interior angles is called what?	A shape is called what when it can be divided down the middle into two identical parts?

At the end of the intervention all class members completed a questionnaire (appendix B), and five volunteer students underwent a semi-structured interview. Gains in student progress were also measured through year level common tests.

The results of the pilot study were encouraging, with students providing positive feedback, and making good progress in mathematics overall, as measured by class tests, improved homework and completed quizzes.

The following example of an advance organizer was used with this class (see below). The advance organizer was fleshed out with students' contributions during class time. This is an example of what was up on the television screen as they entered the classroom.

Example 2. Initially the advance organizer had the following headings:

Session number Date	**Advance Organizer**
Topic	Symmetry
Sub-topic	Reflection, Rotation, Transformation
Links to prior knowledge	Prompt question: Where do you see symmetry in life?
Rationale	To raise our awareness of, and develop an understanding of symmetry, and its place in the wider environment.
Vocabulary	mirror line object clockwise perpendicular reflection translation vectors centre of rotation rotation image invariance transformation
Concepts	Many practical problems can be solved with the use of geometrical models. Developing an understanding of geometrical properties and the symmetries of everyday objects increases our spatial awareness, and enables us to recognise and appreciate their occurrence in the environment.
Organization	Whole class instruction and clarification Human treasure hunt of word definitions In pairs draw an example of – reflection – rotation – transformation Be ready to describe, explain what you did to another classmate.
Outcomes	You will be able to use your own language, mathematical language, and diagrams to describe symmetry and provide examples from everyday life.

The Year 10 class was selected by the teacher on the grounds they were producing inferior work. There were issues with both the quality of the work, and the amount of work the students were producing. The poor attitude of students towards their work was indicated by their coming to class without the necessary gear, lack of homework completion, general negative comments and untidy presentation of class work. In this class the study was carried out for four periods per week over three terms.

On introduction of the advance organizer strategy to these students, they reported having difficulty relating to the headings. Initially it was thought that in the secondary school setting the language used in the advance organizer should reflect the maturity level of the students, and so headings such as 'rationale' and 'prior knowledge' were used. This language seemed off putting to some students, and so the 'advance organizer' became the 'learning helper', 'prior knowledge' changed to 'what do we already know?' and 'rationale' changed to 'why are we doing this?' The headings, adapted from Raewyn Parker's research on the use of advance organizers (1998), became:

Learning Helper

- Topic
- What do we already know?
- Why are we doing this?
- New words
- What are we going to do?
- By the end of this lesson you will

Also, to help students evaluate the lesson in terms of their developing understanding, the teacher collaborated with them and wrote the learning intention on the board - 'by the end of the lesson you will be able to…' He advised students to ask themselves if they could do whatever had been identified. This was to give the class a sense of responsibility for their own learning, and to encourage self-management skills.

Information in the, 'What do we need to do?' row included the page and exercise number the students needed to complete before they left the classroom. This simple device demonstrated clearly the teacher's expectation for completed work, and further encouraged students developing self-management skills. The advance organizer provided all the information they needed to complete the lesson in the given time, and was there as a reference if needed.

Refinements continued to be made to the advance organizer with this class, the most notable being the introduction of the organizer as a participatory organizer. It was decided that the heading 'why are we doing this?' on the advance organizer would be left blank, and that the students would generate ideas for this. An interesting point to note is that the teacher indicated he found this section of the advance organizer difficult to complete. After spending years delivering the curriculum, finding other reasons for the teaching, and consequent learning was at times elusive. He commented, 'I think I'm doing it 'cos it is in the curriculum, and they think they are doing it 'cos I said so. We have all got to start thinking about what we are doing, and why.' It was hypothesised that using student generated ideas for this part of the advance organizer would not only improve the interactive nature of this part of the lesson, but would also help students to extend and develop their understandings of mathematical concepts, and help them make connections between mathematics and the wider world.

Other aspects of the intervention remained the same as in the pilot. Students used literacy strategies, completed written tests, and also had the opportunity to provide oral feedback during conferencing and class discussions. In summary, data collection included a measure of on-task behaviour, a class questionnaire, end of topic common tests, meeting records and interview transcripts.

Matching activities included the 'human treasure hunt,' were students had either a question or an answer and had to find each other (example 3). When all students paired, they read their question and answer to the whole class.

Example 3. Questions and answers.

Sine and cosine are always between?	Zero and one
Theta is the unknown?	Angle
The ratio of sine is?	Opposite and hypotenuse
The ratio of cosine is?	Adjacent and hypotenuse
The ratio of tangent is?	Opposite and adjacent
How do you put your calculator onto degrees?	Use mode
What do you use to calculate an unknown angle?	The inverse of trig
What is the longest side called?	Hypotenuse
What is the side opposite the angle called?	Opposite side
What side is next to the angle, but is not the hypotenuse?	Adjacent

Group activities were also used to help students retain information, and practice and understand new terms. One such game was with blocks, which had written on each side a term and a meaning (example 4). On throwing the block the student had to say the meaning of the word, or say the word that matched the meaning. If they could not answer, the other members of the group would help. To win the game each group member had to be familiar with each of the words and definitions stated on the block. This encouraged supportive and encouraging relationships and helped establish a culture of shared success.

Example 4. Words and definitions.

Term	**Meaning**
Hypotenuse	The ratio between the adjacent and the hypotenuse sides
Opposite	The side of a triangle opposite the given angle
Cosine	Side of a right angled triangle opposite the right angle, the longest side.
Sine	The ration between the opposite and hypotenuse sides
Tangent	The side next to the given angle (connected to the given angle)
Adjacent	The ration between the opposite and adjacent sides

Games were often designed to support any gaps or confusion observed by the teacher and researcher during the lesson, and so the content of different games could be very similar, but presented to students in a different way.

Students were included as partners in the research process (Atweh, Christensen & Dornan, 1998). The teacher held open discussions with the class around how their attitude and behaviour was impacting on their learning, and explained he was going to try some strategies to make learning more fun, purposeful and easy. Altrichter (1993) writes, 'by investigating a situation they [students] themselves are deeply implicated in, they also scrutinize their own contribution to this situation and, consequently, their own competency and self-concept'. Altrichter opines this gives rigor and seriousness to the process, and this was an important facet of this work. Apart from raising students' awareness to their own behaviour, and how this contributed to their experience of the learning context, including them as collaborators in the intervention suggested to them that they could solve problems that affected them, find solutions and work towards them.

This steered away from the punishment/blame scenario that can arise in classrooms where students are uncooperative, but provided a challenge to the teacher and researcher in that students' ideas needed to be incorporated into lesson plans on an ad hoc basis. Essentially students wanted to have fun while they learnt. When the teacher introduced the advance organizer, he informed students he would use this at the start of every lesson, to introduce the topic and lesson sequence.

Results

Effects on on-task behaviour

The results indicate the presentation of an advance organizer and other strategies to support comprehension and vocabulary acquisition improved on-task behaviour, and learning outcomes for students. Over the four observations taken to establish baseline the average on-task behaviour was measured at 80%. Within the first week of the intervention, on task behaviour was measured at 100%, and this remained mostly consistent throughout. This was not a true reflection of the behaviour of many students, who were disengaged from the learning process, but who displayed similar behaviours to those students who were on task. They looked at the white board, picked up their pens, seemed to write answers down and flicked through pages of their textbooks. On closer examination it was discovered that very little or no work had been completed by many of these students. Because of this, other measures were introduced to determine on-task behaviour. One of these was the insistence by the teacher of a minimum amount of work done each lesson, before students were released for interval or lunchtime. The teacher checked workbooks before students could leave the room. If insufficient work had been completed, students had to stay behind to catch up. This rule was easy for the teacher to enforce, as every mathematics lesson preceded either interval or lunchtime. This strategy was highly effective, and one some students commented on as being very helpful in encouraging them to produce the necessary work.

What students felt was effective

Table 1. Results of class questionnaire

1.When you used the advance organizer, did you?	like it a lot	like it sometimes	no feeling about it	dislike it
	2	14	7	2
2.Did the advance organizer help you get started more quickly?	yes	sometimes	no	
	3	16	5	
3.Did the advance organizer help to keep you?	very focussed	focussed	sometimes focussed	no difference
	0	10	7	7
4.Did the advance organizer help you to do more work that you normally do?	yes	sometimes	no	
	6	11	7	
5.What helped you to remember new words and mathematical terms?	the word games	the advance organizer	neither	
	13	9	3	
6.Did the advance organizer help you to understand what you were learning about?	yes	sometimes	no	
	8	13	2	
7.Did the advance organizer provide you with a way of self-assessing how well you had worked each lesson?	yes	sometimes	no	
	5	12	7	

Twenty-four students completed a questionnaire during class time (table 1). Results from the class survey show 21 students felt that the advance organizer helped them to gain comprehension of the material studied. Nineteen of the 24 students thought the advance organizer helped them get started on work more quickly, and 17 students thought it helped them improve work output. When considering vocabulary acquisition, 13 students thought the matching activities and word games helped them with memory retention, and 9 students thought advance organizers helped them acquire and retain new vocabulary.

Items 8 and 9 of the questionnaire asked students to comment on changes they made to their behaviour, both academic and social, and asked them to comment on any changes they observed taking place in the class as a whole. Responses included:

- "I worked with people who would help me".

This refers to some students making a decision to sit next to people in the classroom that would support their learning, rather than sitting next to people who provided distractions.

- "I would try and listen to the teacher more."
- "I did my work, and stuck to it.
- "I focused very hard to achieve. I tried to complete every task that was set. I stopped talking some."

These comments show a level of self-determination that may be in part the result of students being highly involved in all stages of the research process. There was also a certain amount of peer pressure to do better, which evolved in the group, as reflected in some of the comments given in response to the question "...did you notice any changes taking place in the class as a whole?" Answers to this question included:

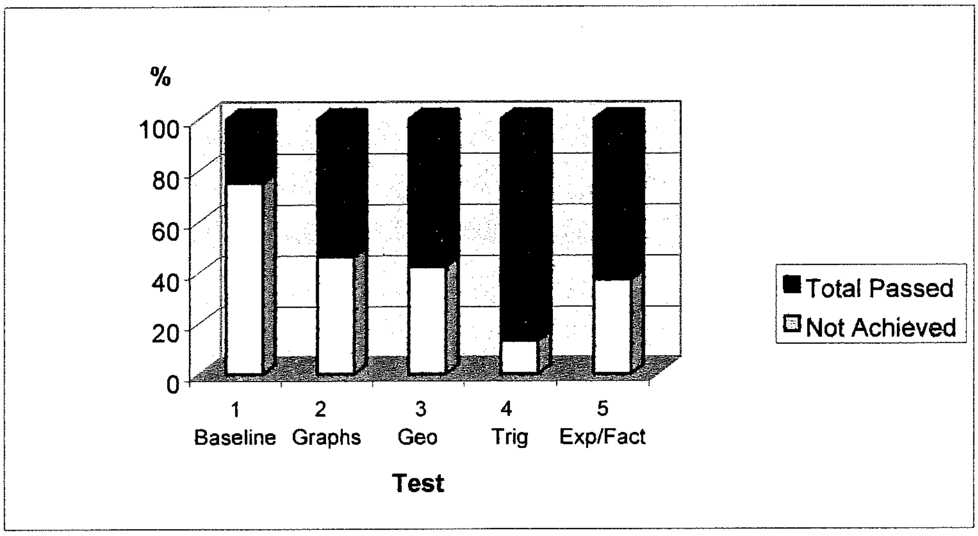
- “There wasn’t much bullying and at the start of the lesson everyone settled down and was quiet for the teacher to teach”.
- “The class seemed to work better. There was less talking and more people working”.
- “Yes, we all did more work as a whole”.
- “Everyone worked well”.
- “More people did more work”.

These perceptions were reflected in improved scores for students as measured by common tests set by the teacher. Throughout the year five common tests are given to all Year 10 classes across the school. These tests have been written collaboratively by the teachers in the mathematics department and are used at the end of the topic to measure how proficient students are in performing previously identified achievement objectives.

The five tests covered achievement objectives taken from the strands of the New Zealand Mathematics Curriculum and are identified in Figure 1 as number, (referred to as baseline), graphs, geometry (Geo), trigonometry (Trig) and expanding and factorising (Exp/Fact). As can be seen from the graph there is a steady increase in student achievement, until test number five, expanding and factorising, where there is a slight increase in the amount of students who gained not achieved.

Effects on achievement in tests

Figure 1: Results of Year 10 common mathematics tests.



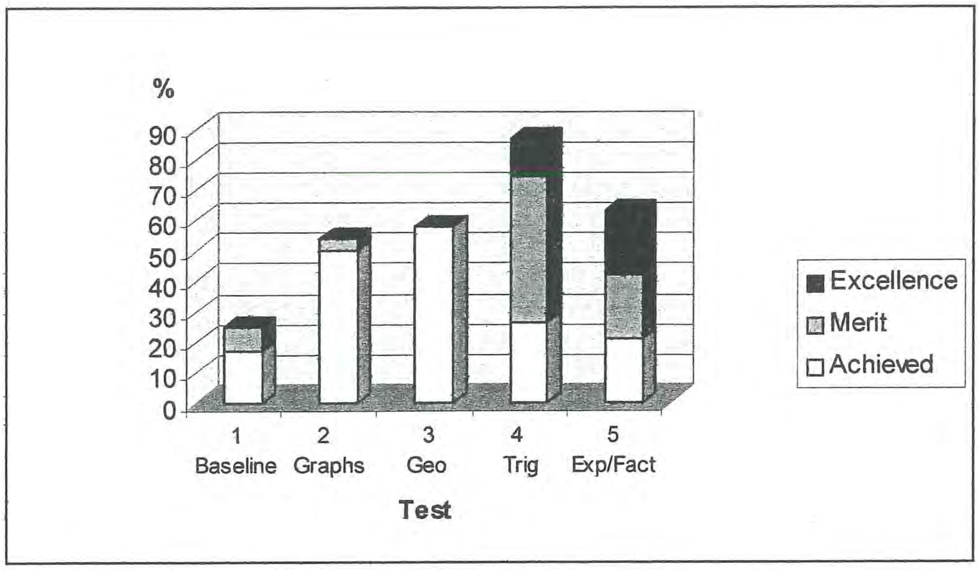
Total Passed and Not Achieved by Test

In Figure 1 the percentage of students scoring a pass mark during Year 10 common tests improved from 25% at baseline, to 83% in test four, decreasing to 63% at test 5.

Baseline was the first of the series of common tests the students performed and covered the strand number. Although each test on the graph measures different knowledge domains, the tests are standardised at the same curriculum level and should be achievable to all students in the class. Consequently it is valid to use these tests as a measure of improved student progress.

The number of students not achieving was more that halved, from 75% at baseline to an average of 35% of students over the four tests. The total pass rate increased by 40% on average over the four tests, with an average of 65% of students gaining an achieved score or better, for tests 2 to 5. The most remarkable improvement in test scores happened in test 4, trigonometry.

Figure 2: Total Passed by Test



At baseline the percentage of students gaining an achieved pass was 17%, as mentioned above, this first test covered the strand number, usually the easiest strand for most students. Over the next four tests an average of 39% of students gained achieved passes, this is more than double the number at baseline.

The number of students gaining merit and excellence passes increased significantly in tests 4 and 5, with 48% of students gaining a merit pass in test 4 and 13% gaining an excellence pass. In test 5, 21% of students gained a merit pass, and the same number gained an excellence pass. In comparison, no excellence or merit passes had been awarded at baseline, or at tests 2 and 3.

In comparison with other Year 10 mathematics classes at the school, the proportion of merit and excellence passes this class gained was significantly higher.

Results of semi-structured interview

The first four students to respond to a request for volunteers were interviewed. Their responses were recorded on tape and later transcribed. These insightful comments added and extended the information already gathered, by providing a range of perspectives. All four students felt they had benefited from using the advance organizer, but in different ways. When asked "Are there any differences in the way you behave in maths compared to other classes?" three out of four students responded with "yes". They voiced these differences to be, settling down to do work straight away, doing more work, and one student experienced a change in attitude towards maths, from thinking that maths was something to be tolerated, to the opinion that "now its [maths] fun, its easy".

All four students highlighted the literacy strategies as being useful. Two students felt the teachers explanations of new words as he went through the advance organizer at the start of the lesson made a difference to them, the other two felt that the word games made the learning more fun and was helpful in vocabulary acquisition. Student comments included, 'how you went through the new words and all that was easier for me', and,'probably the most helpful thing was knowing what the words were, cause we wouldn't have paid attention to them'. Three of the four students mentioned the word 'fun' when describing positive changes to the classroom programme. Their belief that learning can and should be fun was implied in their responses.

The students interviewed ranged in ability from very capable to less able. It is not always possible to identify more able from less able students from test scores alone. For example student A is far more able than student C, however on first perusal of the test results (table 2.) this is not immediately obvious. Student C passed 60% of the set tests, and Student A passed only 40%. However Student C was far more motivated than Student A, and had developed a strategy to help her succeed in the classroom. This involved sitting next to Student B and being informally peer tutored. Being motivated meant that student C was able to quickly select from the intervention those things that promoted her learning. These she identified as the word games, high teacher expectation, and the positive tone of the classroom environment.

Table 2. Results of the four students interviewed.

Name	Test 1 Baseline	Test 2 Graphs	Test 3 Geometry	Test 4 Trigonometry	Test 5 Expanding/factorising
Student A	not achieved	not achieved	not achieved	merit	excellence
Student B	merit	merit	achieved	merit	merit
Student C	not achieved	achieved	achieved	merit	not achieved
Student D	achieved	not achieved	achieved	merit	achieved

When asked the question, 'What were the things that helped you to learn?' she responded that she liked not only the quizzes, but also the implementation of the rule that a minimum amount of work had to be done before individual students could go for interval or lunch-time. This meant, she claimed, that she produced more work and consequently experienced more practice.

Student A made remarkable progress during the intervention, scoring three not achieved for the first three tests, and then a merit, and on the last test an excellence. During the course of the research his attitude and academic behaviours changed significantly. His explanation for this was that the intervention helped him to 'settle down to [his] work straight away'. He felt that the advance organizer helped him 'stay on track' and also commented that high teacher expectation affected his work output in a positive way. He discussed a science teacher who was very strict, but could not get the class to work. This was because of the yelling and screaming the teacher did. He said, 'it makes you not want to get on with the task if they're yelling and screaming'. He commented, 'It's easier to work if the class is settled and stays settled'. At this point he was referring to the way the advance organizer was used at the start of each lesson to, amongst other things, cue the students into the lesson purpose. The advance organizer helped to establish clear classroom routines that students knew and followed. This resulted in a learning environment that was well managed and students responded by producing more work of a higher quality.

Results of teacher and researcher meetings

Initially these discussions focussed on the advance organizers, and the practicalities of preparing and presenting them daily to the class. From the beginning the teacher found this aspect of the study manageable, but wanted to explore ways to increase student involvement at the start of the lesson.

The teacher identified a number of positives that came about from the implementation of the study. These included more focused teaching and learning, students using the vocabulary of mathematics more readily and the ease of using the technology in the classroom. One area of concern was the added time it took to do the hands on activities that supported the teaching and bookwork. However the teacher was philosophical about this, and concluded that quality teaching and learning takes time. It was exciting to observe, during one class, how the students generated a mathematical theory after doing hands on activities and bookwork. During reflection time with the teacher he commented, 'that was probably the best way I've ever seen it done', in relation to how the students had worked together to formulate the theory and then test their hypothesis.

Conclusion

The results of the present study support the combining of advance organizers with other strategies, to improve enjoyment of learning, and learning outcomes for students. The multi-method approach of the study allowed data from a number of sources to be collected, including a questionnaire, common tests and student interviews. Data from all sources consistently indicated positive outcomes for students. However, it is impossible to determine the affects of specific aspects of the intervention on student learning or behaviour because of the quasi-experimental nature of the design, and the inclusion of a number of unplanned variables, such as the requirement of a certain amount of work, before leaving the classroom.

Students' comments indicate that different strategies appealed to some more than others. During the presentation of the advance organizer the teacher went over new vocabulary and its' meaning while students listened, and followed with their eyes. During word games students often had to manipulate cards, read, share and explain their answers. How positively these strategies impacted on the learning of individual students may have depended on whether the student preferred to learn through visual, aural or kinaesthetic means. Obviously the extra practice provided through word games and the increased work output of many students, also made a difference to comprehension and vocabulary acquisition through increased opportunity to interact with the material to be learnt.

Student motivation was observed to improve. Generally, all students completed homework, and the tone in the classroom was positive. Students commented they wanted to do well, and improved scores on tests supported this. The dip in achieved scores for test 4, expanding and factorising, could have been due to time constraints. The delivery of the other topics had taken more time than was ordinarily spent, and so the amount of time for the last topic before the end of term was cut short. Another reason was that the teaching of this topic did not lend itself well to word games, crosswords and quizzes, and so students did not receive as much added practice, or as wide a variety of teaching strategies during this topic. Despite this the teacher was pleased with the number of achieved passes in this test, compared to previous Year 10 classes, and other Year 10 classes in the school.

Most students reported they enjoyed the variety of strategies used during the intervention, some describing the activities as fun. Increased levels of enjoyment may also have contributed to better learning outcomes for students by promoting higher levels of engagement with set tasks. Overcoming student inertia, or poor attitude towards work can be difficult for classroom teachers. Students may readily respond to the novelty of new resources, or a change in teaching methods, but maintaining an increased level of interest over time can be more difficult. Sustaining high levels of student interest was a factor when designing instructional strategies. Consideration was given to promoting high levels of interaction between students, and also making tasks achievable, quick and fun to complete.

Establishing classroom routines that were clearly understood and followed also assisted some students to learn. One student clearly articulated how the classroom environment played an important part in his attitude towards teachers and subsequently learning. He described a correlation between good teacher management of the learning environment, and a positive student attitude towards work.

The findings of this research could be attributed to a number of variables within the learning environment. Ysseldyke, Christenson and Thurlow (cited in Parker,1998), identified a number of instructional factors that positively influence student learning. Many of these factors were present during the intervention, including effective classroom management, clear and specific instructional procedures and a positive classroom environment. The teacher established high expectations and established consequences for students who did not attempt to meet these expectations. Initially students were resentful of these changes in classroom routines, but within a short time all students were completing the required minimum amount of work or more, and the teacher did not have to ask anyone to stay behind over interval or lunchtime. As mentioned previously, some students later commented on how this had helped them to produce more work, and therefore gain more practice on completing examples. This they saw as a positive thing.

The present study had several limitations, which may have affected the results. Having students closely involved in the research process meant many students became committed to its success; most students also developed warm relationships with the teacher and myself. How significantly this impacted on the positive results is unclear but may indicate weaknesses in both the internal and external validity of the research. Students underwent a positive change in attitude towards mathematics, and also matured considerably over a relatively short period of time. These changes may have resulted in improvements to their achievement that was independent of the strategies used. However, the control group did not experience the same level of improvement to scores, despite experiencing a similar level of maturation and an equally supportive and caring learning environment. An examination of the achievement data of this class revealed no passes for excellence or merit awarded over the five tests. Records of achievement data for this group were not made available to the researcher, but were reported to her during a teacher meeting.

It is difficult to determine the effectiveness of any one strategy used during the intervention because strategies were developed in combination. However it is clear from the evidence that students could identify what worked for them. By providing a selection of strategies the intervention became more powerful at an individual level. Perhaps the next step to study would be to explore with individual students, which strategies were most effective in promoting their learning and why. Raising students' awareness of the learning process, and encouraging their active involvement when designing instructional materials and environments, may help to overcome the inertia and disengagement prevalent amongst many high school students at this year level.

The findings of this study support those of Braselton and Decker (1994). When students are given a framework for thinking, and the opportunity to practice, explore and negotiate new learning in ways they deem fun and useful, learning is enhanced. The combination of strategies to integrate both language and mathematics skills increased students ability to function as independent problem solvers, and provided them with the word knowledge necessary to discuss and gain clarification of developing ideas amongst themselves.

This study hypothesised that students could be empowered use the advance organizer to scaffold their learning, enabling them to make connections for themselves, to be more willing to take responsibility for, and to determine the usefulness of current, and future learning. By using the advance organizer as an aid to learning, and with the benefits of the learning dialogue generated by the literacy strategies, students showed an increased ability to make connections for themselves and to be more willing to take responsibility for their learning. The outcomes of this were clearly measurable in student progress.

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Appendices

Appendix A	Interval Recording Sheet
Appendix B	Class Questionnaire
Appendix C	Consent Forms
Appendix D	Letter to the Principal and Board of Trustees

Interval Recording: On/Off Task and Researcher Comments

Class – Yr. 10	Subject - Maths
Time -	Date -

student	1	2	3	4	5	6	7	8	9	10	%

Total =	Inappropriate behaviour codes	Appropriate behaviour codes
Divided by ten =	II – not following instructions IM – inappropriate large movement	AV – appropriate verbalisation AT – appropriate work with teacher
Class average =	Im – inappropriate small movement IS – inappropriate attention seeking	AS – appropriate attention seeking AR – appropriate reading behaviour
Range =	IN – inappropriate noise IF – Focus away from the lesson	AC – appropriate copying AP - appropriate play
No of students =	IV – inappropriate vocalization IOS – inappropriate out of seat	AI - appropriate following instructions AA – appropriate academic

Comments/anecdotal observations

What I think about the advance organizer

1. When you used the advance organizer did you

like it a lot *like it sometimes* *no feeling about it* *dislike it*

2. Did the Advance Organizer help you get started more quickly?

yes *sometimes* *no*

3. Did the Advance Organizer help to keep you

very focused *focused* *sometimes focused* *no difference*

4. Did the Advance Organizer help you to do more work than you usually do?

yes *sometimes* *no*

5. What helped you to remember new words and mathematical terms

the word games *the advance organizer* *neither*

6. Did the Advance Organizer help you to understand what you were learning about?

yes *sometimes* *no*

7. Did the Advance Organizer provide you with a way of self- assessing how well you had worked each lesson?

yes *sometimes* *no*

8. Please comment on any changes you made to your behaviour during class and/or with homework since we have been using the advance organizer

____
____
____
____

9. If you did not need to make any changes to your behaviour, or with homework, did you notice any changes taking place in the class as a whole? Please comment.

____
____
____
____

☺ ***Thank you for completing this questionnaire*** ☺

CHRISTCHURCH
COLLEGE of EDUCATION
Te Whare Whai Matauraka Ki Otautahi

Information for Parents/Guardian of Participants

My name is Harriet Donaldson. I am working towards a Masters of Teaching and Learning at the Christchurch College of Education. As part of my degree I am required to undertake a research project. I will be working under the supervision of Ronnie Davey, Principal Lecturer in the Schools of Secondary Teacher Education and Professional Development at the Christchurch College of Education. Permission has been obtained from the Principal and the Board of Trustees of the school to undertake this project.

My project is called: Do advance organizers and other literacy strategies promote student learning in maths?

What is the aim of the research project?

The aim of this research is to evaluate the effectiveness of advance organizers in promoting comprehension and vocabulary acquisition in maths. I will also observe the impact, if any, on academic engaged time when advance organizers and games designed to increase understanding and recognition of mathematical terms become part of the classroom routine.

What types of participants are sought?

One class of Year 9 students and one class of Year 10 students.

What will participants be asked to do?

1. Students will be observed in the classroom. These observations will be recorded using a coded sheet, seen by the researcher and teacher only.
2. 5 students form Year 9 and 5 students from Year 10 will volunteer to undergo a semi-structured interview, which will be transcribed for later analysis. These students will be interviewed individually and the interviews will be of approximately 10 minutes duration.
3. All students will participate in games designed to improve word acquisition and understanding of mathematical terms.
4. At the Year 10 level all students will complete a written questionnaire at the end of the project, and all students will be given the opportunity to share their thoughts and ideas about the project during weekly class discussion times.
5. Class tests will be scrutinized and compared with tests undertaken prior to the research process being implemented.

How much time is involved?

The questionnaires should take about 30 minutes to complete and this will be done in class time. The discussions and observations will be carried out within the regular maths class. The discussions will take 5 – 10 minutes and the observations will be carried out whilst the students are working.

How will confidentiality and anonymity be addressed?

No findings that could identify any individual participant will be published. The questionnaires are not named and the observation forms are coded. Only my supervisor and I will have access to the data, which will be stored for at least five years as prescribed by the College regulations.

Are all students required to participate?

No, participation is voluntary.

What happens to students who chose not to participate?

All students on the class roll will of course be in the classroom when the advance organizers are being used by the teacher. However students who do not wish to participate will not be expected to fill out a questionnaire, participate in class discussions or be included in the observation data. Students who do not participate will not be penalized or disadvantaged in any way.

If I agree to let my child take part, can I change my mind and withdraw my child from the study?

If you agree to have your child take part, you can withdraw your consent at any time. Parents may do this by notifying me by phone or in writing. Students may withdraw by submitting a blank questionnaire and by not participating in class discussions. They need to notify me by phone, in writing or by simply discussing it with me during class time.

The Christchurch College of Education Ethics Committee has reviewed and approved this study.

Complaints Procedure

The College requires that all participants be informed that if they have any complaint concerning the manner in which a research project is conducted, it may be given to the researcher, or, if an independent person is preferred, to:

The Chair
Ethical Clearance Committee
Christchurch College of Education P.O. Box 31 – 065
Christchurch
Phone: (03) 348 2059

Please contact me if you have any other queries or concerns about the project or would like to be informed of the aggregate research finding. I can be reached by phone on: 03 352 6119 ext 816 or by email: donaldsonh@papanui.school.nz

Thank you.

Harriet Donaldson

CHRISTCHURCH
COLLEGE of EDUCATION
Te Whare Whai Matauraka Ki Otautahi

Student Consent Form

Dear Student

This form is to invite you to agree to participate in an interview for the following research project.

My project is called: Do advance organizers and other literacy strategies promote student learning in maths?

Please sign the consent form if you have read and understood the information provided on the attached sheet, and have gone over the information with your parent or caregiver, and have their approval.

Please understand the information you provide will be:

- Anonymous
- Tapes, data and written material will be kept secure and not available to other parties.
- You may withdraw from the study at any time.
- If you withdraw from the study then any data you have contributed may also be withdrawn.
- That your participation is completely voluntary
- If you choose not to be interviewed, you will not be penalized or disadvantaged in any way.

Student's Name ______________________________

Student's Signature ______________________________

Date ______________________________

Parent/Caregiver's Name ______________________________

Parent/Caregiver's Signature ______________________________

Date ______________________________

Thank you for being part of this ongoing research.

Yours sincerely

Harriet Donaldson

CHRISTCHURCH
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Letter to the Principal and Board of Trustees

Dear Principal and Board of Trustees

I would like to apply for permission to carry out a simple research project in a Year 9 and a Year 10 maths class with Peter Gill. Peter is a voluntary participant who wishes to try new strategies in his classroom. I will design and help him implement the project as part of a requirement to complete a Masters in Teaching and Learning with the Christchurch College of Education. Peter will be a full participant researcher and I will be a participant/observer collecting all data for analysis and writing the research report.

The project is designed to answer the following questions: Do advance organizers promote comprehension and vocabulary acquisition in maths? What is the impact on academic engaged time when advance organizers and literacy games become part of the classroom routine during maths?

The results will be confidential but made available to you at the conclusion of the research. A copy of the research report, in which no names will be identified, will be provided. There will be no disruption to classes and participants will be kept informed at all stages of the project. Parent and student consent will be obtained.

Many thanks

Harriet Donaldson
(RTLB)